Application No. 10/087,566

AMENDMENTS TO THE SPECIFICATION

In the Specification

Please substitute the following amended paragraph(s) and/or section(s) (deleted matter is shown by strikethrough and added matter is shown by underlining):

Page 3, line 4-line 12:

Heretofore, various methods have been proposed to bond an aluminum plate and a ceramic substrate board using a brazing material as shown in Japanese Unexamined Utility Model Publication No. 57945/1991 and Japanese Unexamined Utility Model Publication No. 68448/1990. Among these methods, an aluminum plate is bonded to an aluminum nitride board or an alumina board by using a brazing material of Al--Si series or Al--Ge series. U.S. Pat. No. 3,994,430, published on 1976, shows the use of ~~silicone~~ silicon as an aluminum binding assistant. Further, Japanese Unexamined Patent Publications No. 193358/1995 and No. 276035/1955 disclose such a method that aluminum in molten state is contacted with a substrate board of aluminum nitride or an alumina substrate board, and the aluminum is solidified, so that the aluminum is bonded directly to the substrate board.

Page 5, line 2-line 9:

It is sufficient to add [[an]] another metal element such as ~~silicone~~ silicon to the aluminum in order to realize the above hardness of the predetermined range. ~~Silicone~~ Silicon is suitable, because it is diffused easily in the aluminum and it makes a eutectic at a low temperature. In order to realize the Vickers hardness of not less than 25 and not more than 40, ~~silicone~~ silicon of not less than 0.2 weight % and not more than 5 weight % is required. It is possible to add further Mn, Mg or the like.

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Page 5, line 23-line 24:

The metal alloy layer includes ~~silicone~~ silicon of not less than 0.2% by weight and not more than 5% by weight. The metal alloy layer includes Mn of not more than 1.5% by weight.

Page 6, line 4-line 6:

The ceramic substrate board is made of a material selected from a group consisting of alumina, aluminum nitride, and ~~silicone~~ silicon nitride.

Page 7, line 1-line 17:

In a first example of the present invention, as shown in FIG. 2, a raw material 11 including aluminum of 99.8% by weight and ~~silicone~~ silicon of 0.2% by weight were set in a concave portion 10 formed at an upper portion of a crucible 9 of graphite. The concave portion 10 was closed by a piston 12 of graphite. A ceramic substrate board 14 of aluminum nitride of 0.635 mm in thickness was set in a cavity 13 formed at a lower portion of the crucible 9. Then, the crucible 9 was inserted into a furnace heated at 800°C. As a result, the raw material 11 was molten and pushed out by the weight of the piston 12 into the cavity 13 including therein the ceramic substrate board 14. The crucible 9 was taken out of the furnace and cooled at a room temperature. In this example 1, the heating and cooling of the crucible 9 were performed in an atmosphere of nitrogen gas in order to prevent the crucible 9 from being oxidized. Thus obtained ceramic substrate having at each of side surfaces thereof an aluminum alloy layer of 0.5 mm in thickness was subjected to the mechanical and electrolytic polishing.

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Page 8, line 3-line 10:

A metal-ceramic substrate board was formed under the same condition as in the example 1 except that the composition of the raw material 11 was formed of aluminum of 99.5% by weight and ~~silicone~~ silicon of 0.5% by weight. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 30. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al-SiC composite material by using a brazing material of eutectic composition.

Page 8, line 16-line 23:

A metal-ceramic substrate board was formed under the same condition as in the example 1 except that the composition of the raw material 11 was formed of aluminum of 98% by weight and ~~silicone~~ silicon of 2% by weight. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 35. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al-SiC composite material by using a brazing material of eutectic composition.

Page 9, line 16-line 22:

A metal-ceramic substrate board was formed under the same condition as in the example 2 except that ~~silicone~~ silicon nitride was used as the ceramics. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 30. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al--SiC composite material by using a brazing material of eutectic composition.

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Page 10, line 3-line 14:

A plate of 0.4 mm in thickness consisting of aluminum of 99.5% by weight and ~~silicone~~ silicon of 0.5% by weight was laminated on each of both side surfaces of aluminum nitride substrate board of 0.635 mm in thickness through a brazing material layer of 50 μ in thickness consisting of aluminum of 87.5% by weight and ~~silicone~~ silicon of 12.5% by weight. Then, the plate was inserted into a furnace heated at 640°C. As a result, a metal-ceramic substrate board was formed of an aluminum alloy plate and aluminum nitride. The Vickers hardness of the aluminum alloy layer of the substrate board was 31. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al–SiC composite material by using a brazing material of eutectic composition.

Page 10, line 20-page 11, line 3:

A metal-ceramic substrate board was formed under the same condition as in the example 1 except that the composition of the raw material 11 was formed of aluminum of 97.9% by weight, ~~silicone~~ silicon of 0.6% by weight, and Mn of 1.5% by weight. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 32. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al–SiC composite material by using a brazing material of eutectic composition. Here, Mn was used to increase the hardness.

Page 11, line 9-line 17:

A metal-ceramic substrate board was formed under the same condition as in the example 6 except that the laminated plate was formed of aluminum of 98.6% by weight, ~~silicone~~ silicon of 0.4% by weight, and Mg of 1% by weight. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 30. Then, a power module was formed by

combining the metal-ceramic substrate board with a base plate of Al--SiC composite material by using a brazing material of eutectic composition. Here, Mg was used to increase the hardness.

Page 13, line 24-page 14, line 5:

A metal-ceramic substrate board was formed under the same condition as in the example 11 except that ~~silicone~~ silicon nitride was used as the ceramics. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 27. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al--SiC composite material by using a brazing material of eutectic composition.

Page 15, line16-line 22:

A metal-ceramic substrate board was formed under the same condition as in the example 15 except that ~~silicone~~ silicon nitride was used as the ceramics. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 32. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al--SiC composite material by using a brazing material of eutectic composition.

Page 17, line 4-line 15:

A plate of 0.4 mm in thickness consisting of aluminum of 98% by weight and Mn of 2% by weight was laminated on each of both side surfaces of aluminum nitride substrate board of 0.635 mm in thickness through a brazing material layer of 50 μ in thickness consisting of aluminum of 87.5% by weight and ~~silicone~~ silicon of 12.5% by weight. Then, the plate was inserted into a furnace heated at 640°C. As a result, a metal-ceramic substrate board was formed of an aluminum alloy plate and aluminum nitride. The Vickers hardness of the aluminum alloy layer of the substrate board was 25. Then, a power module was formed by combining the metal-

ceramic substrate board with a base plate of Al–SiC composite material by using a brazing material of eutectic composition.

Page 19, line 9-line 15:

A metal-ceramic substrate board was formed under the same condition as in the example 22 except that ~~silicone~~ silicon nitride was used as the ceramics. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 27. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al--SiC composite material by using a brazing material of eutectic composition.

Page 21, line 9-line 15:

A metal-ceramic substrate board was formed under the same condition as in the example 26 except that ~~silicone~~ silicon nitride was used as the ceramics. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 33. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al–SiC composite material by using a brazing material of eutectic composition.

Page 22, line 22-page 23, line 4:

A metal-ceramic substrate board was formed under the same condition as in the example 1 except that the composition of the raw material 11 was formed of aluminum of 99.4% by weight, ~~silicone~~ silicon of 0.1% by weight, and Mg of 0.5% by weight. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 28. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al--SiC composite material by using a brazing material of eutectic composition.

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Page 23, line 10-line 22:

A plate of 0.4 mm in thickness consisting of aluminum of 99.4% by weight, Mg of 0.5% by weight and ~~silicone~~ silicon of 0.1% by weight was laminated on each of both side surfaces of aluminum nitride substrate board of 0.635 mm in thickness through a brazing material layer of 50 μ in thickness consisting of aluminum of 87.5% by weight and ~~silicone~~ silicon of 12.5% by weight. Then, the plate was inserted into a furnace heated at 640°C. As a result, a metal-ceramic substrate board was formed of an aluminum alloy plate and aluminum nitride. The Vickers hardness of the aluminum alloy layer of the substrate board was 28. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al–SiC composite material by using a brazing material of eutectic composition.

Page 24, line 3-line10:

A metal-ceramic substrate board was formed under the same condition as in the example 31 except that the laminated plate was formed of aluminum of 98.9% by weight, ~~silicone~~ silicon of 0.1% by weight, and Cu of 1% by weight. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 32. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al--SiC composite material by using a brazing material of eutectic composition.

Page 24, line 16-line 23:

A metal-ceramic substrate board was formed under the same condition as in the example 32 except that the laminated plate was formed of aluminum of 98.9% by weight, ~~silicone~~ silicon of 0.1% by weight, and Cu of 1% by weight. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 32. Then, a power module was

formed by combining the metal-ceramic substrate board with a base plate of Al–SiC composite material by using a brazing material of eutectic composition.

Page 25, line 4-line16:

A metal-ceramic substrate board was formed under the same condition as in the example 31 except that the laminated plate was formed of aluminum of 98.8% by weight, ~~silicone~~ silicon of 0.1% by weight, Cu of 1% by weight, and Mg of 0.1% by weight. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 33. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al–SiC composite material by using a brazing material of eutectic composition. Here, Mg was used to increase the hardness.

Page 25, line 18-page 26, line 1:

A metal-ceramic substrate board was formed under the same condition as in the example 32 except that the laminated plate was formed of aluminum of 98.8% by weight, ~~silicone~~ silicon of 0.1% by weight, Cu of 1% by weight, and Mg of 0.1% by weight. The Vickers hardness of the aluminum alloy layer of the aluminum substrate board was 33. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al--SiC composite material by using a brazing material of eutectic composition. Here, Mg was used to increase the hardness.

Page 27, line 9-line16:

A metal-ceramic substrate board was formed under the same condition as in the comparative example 1 except that the composition of the raw material 11 was formed of aluminum of 95% by weight and ~~silicone~~ silicon of 5% by weight. The Vickers hardness of the

aluminum alloy layer of the aluminum substrate board was 40. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al- SiC composite material by using a brazing material of eutectic composition.

Page 27, line 21-page 28, line 7:

A plate of 0.4 mm in thickness consisting of aluminum of 95% by weight and ~~silicone~~ silicon of 5% by weight was laminated on each of both side surfaces of aluminum nitride substrate board of 0.635 mm in thickness through a brazing material layer of 50 μ in thickness consisting of aluminum of 87.5% by weight and ~~silicone~~ silicon of 12.5% by weight. Then, the plate was inserted into a furnace heated at 640°C. As a result, a metal-ceramic substrate board was formed of an aluminum alloy plate and aluminum nitride. The Vickers hardness of the aluminum alloy layer of the substrate board was 40. Then, a power module was formed by combining the metal-ceramic substrate board with a base plate of Al—SiC composite material by using a brazing material of eutectic composition.

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Page 33, line 5-line12:

	Example 1	Example 2	Example 3	Example 4	Example 5
Vickers hardness	25	30	35	30	30
composition of aluminum	Al 99.8% Si 0.2%	Al 99.5% Si 0.5%	Al 98% Si 2%	Al 99.5% Si 0.5%	Al 99.5% Si 0.5%
ceramics	aluminum nitride	aluminum nitride	aluminum nitride	alumina	~~silicone~~ silicon nitride
manner of bond	direct bonding	direct bonding	direct bonding	direct bonding	direct bonding
thermal cycle resistance	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle
crack in ceramics	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle
crack in brazing material	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle

Page 34, line 2-line 17:

	Example 11	Example 12	Example 13	Example 14	Example 15
Vickers hardness	27	27	27	30	32
composition of aluminum	Al 99.5 Mg 0.5%	Al 99.5% Mg 0.5%	Al 99.5% Mg 0.5%	Al 99% Cu 1%	Al 98% Cu 2%
ceramics	aluminum nitride	alumina	~~silicone~~ silicon nitride	aluminum nitride	aluminum nitride
manner of bond	direct bonding	direct bonding	direct bonding	direct bonding	direct bonding
thermal cycle resistance	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle
crack in ceramics	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle
crack in brazing material	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle

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	Example 16	Example 17	Example 18	Example 19	Example 20
Vickers hardness	32	32	34	33	31
composition of aluminum	Al 98% Cu 2%	Al 98% Cu 2%	Al 98% Zn 2%	Al 99.5% Ni 0.5%	Al 98% Mn 2%
ceramics	~~almina~~ alumina	~~silicone~~ silicon nitride	aluminum nitride	aluminum nitride	aluminum nitride
manner of bond	direct bonding	direct bonding	direct bonding	direct bonding	bonding by brazing
thermal cycle resistance	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle
crack in ceramics	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle
crack in brazing material	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle

Page 35, line 2-line 17:

	Example 21	Example 22	Example 23	Example 24	Example 25
Vickers hardness	25	27	27	27	31
composition of aluminum	Al 99.8% Mn 0.2%	Al 99.5% Mn 0.5%	Al 99.5% Mn 0.5%	Al 99.5% Mn 0.5%	Al 99% Cu 1%
ceramics	aluminum nitride	aluminum nitride	~~almina~~ alumina	~~silicone~~ silicon nitride	aluminum nitride
manner of bond	bonding by brazing	bonding by brazing	bonding by brazing	bonding by brazing	bonding by brazing
thermal cycle resistance	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle
crack in ceramics	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle
crack in brazing material	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle

	Example 26	Example 27	Example 28	Example 29	Example 30
Vickers hardness	33	33	33	35	33
composition of aluminum	Al 98% Cu 2%	Al 99% Cu 2%	Al 98% Cu 2%	Al 98% Zn 2%	Al 99.5% Ni 0.5%
ceramics	aluminum nitride	alumina	~~silicone~~ silicon nitride	aluminum nitride	aluminum nitride
manner of bond	bonding by brazing	bonding by brazing	bonding by brazing	bonding by brazing	bonding by brazing
thermal cycle resistance	more than 3000 cycle	more than 3000 cycle	more than 3000 cycle	More than 3000 cycle	more than 3000 cycle
crack in ceramics	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle
crack in brazing material	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle	no crack at 3000 cycle

Page 38, line 11-line 16:

Aluminum among the ceramics has a high heat insulating ability and is cheap. The aluminum nitride has a high heat conductivity and a high heat radiation, so that it is preferable to hold heavy current control tip. The ~~silicone~~ silicon nitride has a high strength and a high thermal cycle resistance, so that it can be used in the hard circumstances, such as in the engine room.